

GAO

Report to the Subcommittee on  
Projection Forces, Committee on  
Armed Services, House of  
Representatives

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November 2006

# DEFENSE ACQUISITIONS

## Challenges Remain in Developing Capabilities for Naval Surface Fire Support



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## Why GAO Did This Study

Since the mid-1990s, the Navy and Marine Corps have studied ways to better protect landing forces. As new operational concepts evolved, the Marine Corps identified requirements for naval surface fire support and the Navy began developing two systems to meet these needs—the Extended Range Munition for existing classes of ships and the future *Zumwalt* class destroyer.

GAO was asked to address (1) whether requirements for fire support have been established and (2) the Navy's progress on the Extended Range Munition, *Zumwalt* class destroyer, and follow-on systems. GAO also analyzed whether these Navy systems fulfill the requirements and whether gaps remain.

To address these objectives GAO analyzed key documents on requirements and programs and held discussions with officials from the Navy and Marine Corps as well as other interested organizations.

## What GAO Recommends

GAO recommends that the Department of Defense clarify requirements for volume of fire, clarify Navy and Marine Corps roles in managing resources, comprehensively review the Extended Range Munition program, and assign responsibility for assessing the gap in command and control. DOD concurred with the first and third recommendations, and partially concurred with the others.

[www.gao.gov/cgi-bin/getrpt?GAO-07-115](http://www.gao.gov/cgi-bin/getrpt?GAO-07-115).

To view the full product, including the scope and methodology, click on the link above. For more information, contact Paul L. Francis at (202) 512-4841 or [francisp@gao.gov](mailto:francisp@gao.gov).

# DEFENSE ACQUISITIONS

## Challenges Remain in Developing Capabilities for Naval Surface Fire Support

### What GAO Found

In December 2005, more than a decade after the Navy and Marine Corps began to formulate requirements, agreement was reached on the capabilities needed for naval surface fire support. However, quantifiable measures are still lacking for volume of fire—the delivery of a large quantity of munitions simultaneously or over a period of time to suppress or destroy a target. Until further quantifiable requirements are set for volume of fire, it is difficult to assess whether additional investment is necessary or the form it should take.

The Navy's Extended Range Munition and *Zumwalt* class destroyer have cost more, taken longer to develop and field than anticipated, and will deliver fewer capabilities than originally promised. Largely due to technical challenges, the Extended Range Munition is expected to exceed the original cost estimate for development by 550 percent, and the Navy has delayed delivery of initial capability by 11 years. The munition's path for development and fielding remains uncertain as key technologies and munition design have not been adequately demonstrated. The Office of the Secretary of Defense recently assumed oversight of the program, and while a comprehensive review has not yet been held, there are ongoing studies that could assist such a review. The Navy has reduced *Zumwalt* class land attack munitions by 50 percent and cut ship quantities from 32 to 7. The primary reason for reduced capabilities are cost pressures created by the Navy's original concept of revolutionary performance at an unrealistically low cost. The Navy plans to begin construction of the first two ships in the *Zumwalt* class in fiscal year 2008.

The recent study of future fire support needs approved by the Joint Requirements Oversight Council identifies four capability gaps: command and control of fire support; engaging moving targets in poor weather; engaging targets when collateral damage is a concern; and engaging targets that require a large volume of fire. The analysis that forms the basis of the joint study contends that while the Extended Range Munition and *Zumwalt* class destroyer offer significant capabilities in some scenarios, they do not provide enough capability to meet all fire support needs. The Navy, through its surface warfare directorate, has begun analyzing the three engagement gaps, but the Navy has not chosen an organization to analyze the gap in command and control, which is essential for target assignment and information. Any attempts to accept the risks or invest in programs to fill remaining gaps should also involve the expeditionary warfare directorate as the Marine Corps representative. The expeditionary warfare directorate does not have a formal role in developing requirements, determining capabilities, and managing resources for systems that provide naval surface fire support.

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# Contents

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<b>Letter</b>		<b>1</b>
	Results in Brief	2
	Background	5
	Agreement on Requirements Took over a Decade and Did Not Address Quantitative Measures for Volume of Fire	7
	Naval Surface Fire Support Systems Have Experienced Cost and Schedule Growth and Will Deliver Less Capability Than Originally Planned	12
	Needs for Naval Surface Fire Support Exceed Projected Capabilities	24
	Conclusions	28
	Recommendations for Executive Action	29
	Agency Comments and Our Review	30
<b>Appendix I</b>	<b>Scope and Methodology</b>	<b>32</b>
<b>Appendix II</b>	<b>Comments from the Department of Defense</b>	<b>34</b>
<b>Appendix III</b>	<b>GAO Contacts and Staff Acknowledgments</b>	<b>38</b>
<b>Tables</b>		
	Table 1: Basis for Evolving Requirements	8
	Table 2: Naval Surface Fire Support Requirements	10
	Table 3: Major Events in the Acquisition of the Extended Range Munition	14
	Table 4: Major Events in the Acquisition of the Zumwalt Class Destroyer	19
<b>Figures</b>		
	Figure 1: Fires Triad Illustration	5
	Figure 2: Extended Range Munition	13
	Figure 3: Cost and Schedule Growth in the Extended Range Munition Program	16
	Figure 4: Reductions to Ship Quantities Planned for Naval Surface Fire Support	18

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Figure 5: Advanced Technologies on the Zumwalt Class Guided Missile Destroyer	21
Figure 6: Cost and Quantity Change in the Zumwalt Class Destroyer Program	23

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## Abbreviations

CEP	Circular error probable
CG(X)	Experimental guided-missile cruiser
DD	Destroyer
DDG	Guided missile destroyer
DD(X)	Experimental destroyer
ERM	Extended Range Munition
RDT&E	Research, development, test, and evaluation
SC	Surface combatant

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United States Government Accountability Office  
Washington, DC 20548

November 30, 2006

The Honorable Roscoe G. Bartlett  
Chairman  
The Honorable Gene Taylor  
Ranking Minority Member  
Subcommittee on Projection Forces  
Committee on Armed Services  
House of Representatives

Since the end of the Cold War, the Navy has shifted its focus away from warfare on the open ocean and toward operations in coastal waters. In support of this new focus, the Marine Corps has developed new concepts for landing forces ashore in a hostile environment from ships at sea. These maneuvers—referred to as expeditionary operations—increase the Marine Corps’s reliance on sea-based fire support. According to the Navy and Marine Corps, ship-based guns and missiles, or naval surface fire support, are essential for advancing landing forces to their objectives and protecting them from enemy attack.

From 1992 to the present, the Marine Corps has been working to set requirements for naval surface fire support that reflect evolving operating concepts. The Navy has been developing systems to meet these requirements including the Extended Range Munition, a precision-guided munition with increased range fired from an improved gun on an existing class of ships, and the DDG 1000 *Zumwalt* class destroyer, an entirely new surface ship designed with advanced capabilities specifically for naval surface fire support. When these systems began development, they were expected to begin to be fielded by 2001 and 2008, respectively. Current plans call for fielding to begin in 2011 and 2014. In response to your request, this report addresses (1) whether well-defined requirements for naval surface fire support have been established and (2) the Navy’s progress in developing and fielding the Extended Range Munition, the *Zumwalt* class destroyer, and follow-on systems. We also analyzed whether the Navy’s systems currently under development fulfill the established requirements, and the actions being taken to address any remaining gaps.

To determine whether well-defined requirements for naval surface fire support have been established, we analyzed documentation on the stated needs and operational concepts for ship-based fire support including doctrinal publications and capabilities documents. To supplement our

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analysis, we held discussions with a number of Marine Corps and Navy offices including those responsible for creating requirements, such as the Marine Corps Combat Development Command and the Chief of Naval Operations's Surface Warfare Division. To assess the Navy's progress in developing and fielding systems to meet these requirements, we held discussions and reviewed documents at the program offices responsible for acquiring the Extended Range Munition, the *Zumwalt* class destroyer, and other weapon systems. We also drew from our prior work on these systems. In analyzing whether the systems selected meet requirements for naval surface fire support, we reviewed reports and documentation produced by or in cooperation with the Navy and Marine Corps, such as the *Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document*, as well as the capabilities development documents for the systems themselves. To supplement this information and address the actions taken to close remaining gaps, we met with officials from joint and service organizations in the requirements community. For more information on the methodology used in this report see appendix I. We conducted our analysis from February 2006 to November 2006 in accordance with generally accepted government auditing standards.

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## Results in Brief

In December 2005, an agreement was reached that defined requirements for naval surface fire support in such areas as range and accuracy, but did not include quantifiable measures for volume of fire. The Marine Corps derived these requirements over a decade as its thinking on expeditionary operations evolved. From 1996 to 2002, the Marine Corps communicated requirements derived from these concepts to the Navy in a series of letters. These letters included descriptions of desired capabilities like volume of fire, which the Marine Corps defines as the delivery of a large quantity of munitions simultaneously or over a period of time to suppress or destroy a target, as well as specific requirements for range and accuracy. These capabilities and requirements formed the basis of the needs identified in the *Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document* approved in December 2005 through the joint requirements process. While this document identifies a need for volume of fire as defined by the Marine Corps, a set of specific requirements like those for range or accuracy do not yet exist. Requirements for volume of fire are complicated by the variance in effects desired from mission to mission, although this is a challenge in other warfare areas as well. In addition, there is not yet a clear understanding of how the capabilities offered by precision munitions can be utilized for volume fires in a cost effective manner.

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Developing and fielding the Extended Range Munition and *Zumwalt* class destroyer has required more funding and time than anticipated and may not offer the capabilities originally promised, while the development of follow-on systems has just begun. The cost to develop the Extended Range Munition is expected to exceed the original estimate by over 550 percent and fielding of an initial capability has been delayed by nearly 11 years, largely due to the failure to recognize and plan for technical challenges. While the program's current approach seeks to improve reliability of key components, the viability of the program remains in question until realistic plans for testing, producing, and fielding the munition are approved and the munition's design is demonstrated through testing. Oversight of the program was recently changed from the Navy to the Undersecretary of Defense for Acquisition, Technology & Logistics, who has not yet held a comprehensive review of the program. Cost challenges, stemming primarily from unrealistic expectations, have led the Navy over time to reduce ship capabilities and procurement quantities from the *Zumwalt* class destroyer program. Specifically, the Navy has reduced each ship's land-attack munitions by 50 percent and decreased ship quantities from 32 to 7. These reductions have further increased the Navy's reliance on the less capable Extended Range Munition for naval surface fire support. The Navy continues to develop *Zumwalt* class technologies and design and plans to begin construction of the first two ships in fiscal year 2008. To provide capabilities for naval surface fire support beyond the Extended Range Munition and *Zumwalt* class destroyer, the Navy has begun development of prototypes for the electromagnetic railgun and multipurpose loitering missile. Further progress on these systems is dependent on continued analysis of the capabilities required, identification of system requirements, and advances in technology.

Despite the new capabilities promised by the Extended Range Munition and *Zumwalt* class destroyer, needs for naval surface fire support exceed projected capabilities. Recently, the *Joint Fires* initial capabilities document assessed future fire support needs for operations in the littorals<sup>1</sup> and identified capability gaps in command and control, engaging moving targets in poor weather, engaging targets when collateral damage is a concern, and engaging targets that require a large volume of fire. While the identification of gaps by such a study is not unusual, it is important that

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<sup>1</sup> The littoral includes an area extending from a transition point in the open ocean, to more constrictive and shallower waters, to the shore, and onward to those inland areas that can be attacked, supported, and defended from the sea.



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the gaps be properly analyzed so that informed decisions can be made on whether to accept the gaps or how best to close them. Three issues exist that could inhibit the analysis of gaps identified in capabilities for naval surface fire support. The uncertainty inherent in the Marine Corps's current requirements for volume of fire is one such issue. Any decision to allocate limited resources to fill this gap would benefit from clarification of these requirements. In addition, the Navy's Expeditionary Warfare Division, charged with establishing capabilities and requirements for naval surface fire support, has not had a formal role in managing requirements and allocating resources for the Extended Range Muniton and *Zumwalt* class destroyer, increasing the risk that naval surface fire support capabilities may not align with the requirements and operating concepts of expeditionary warfare. Also, while the Navy is analyzing gaps for engaging targets, it has not identified a lead organization for analyzing gaps in command and control.

We are making four recommendations to assist the Navy and Marine Corps in clarifying requirements and developing systems for naval surface fire support. Specifically we are recommending that (1) the Navy and Marine Corps define requirements and operational concepts for volume of fire to clarify the effects desired and inform the selection and acquisition of fire support programs; (2) the Chief of Naval Operations's Expeditionary Warfare Division, as the division in charge of expeditionary warfare requirements and liaison with the Marine Corps, be given a formal role in developing requirements, determining capabilities, and managing resources for systems that provide naval surface fire support; (3) the Undersecretary of Defense for Acquisition, Technology and Logistics, as decision authority for the Extended Range Muniton, conduct a comprehensive review of the program to validate plans for future development and acquisition; and (4) the gap in command and control of joint fires for littoral operations be assigned to the appropriate organization and coordinated with the Navy's work on engagement gaps.

In comments to a draft of this report, the Department of Defense concurred with our recommendations to clarify requirements and concepts for volume of fire and conduct a review of the Extended Range Muniton program. The department partially concurred with our recommendation to give Expeditionary Warfare a formal role in developing and managing systems for naval surface fire support, stating that a review of existing roles and regulations would be conducted and changes made if necessary. The department also partially concurred with our recommendation to assign an organization to address the gap in command and control of joint fires in the littorals, stating that means to

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address this gap would be investigated later, after initial analysis of engagement gaps is completed. We are concerned that deferring command and control to a later analysis continues a history of inattention to this area.

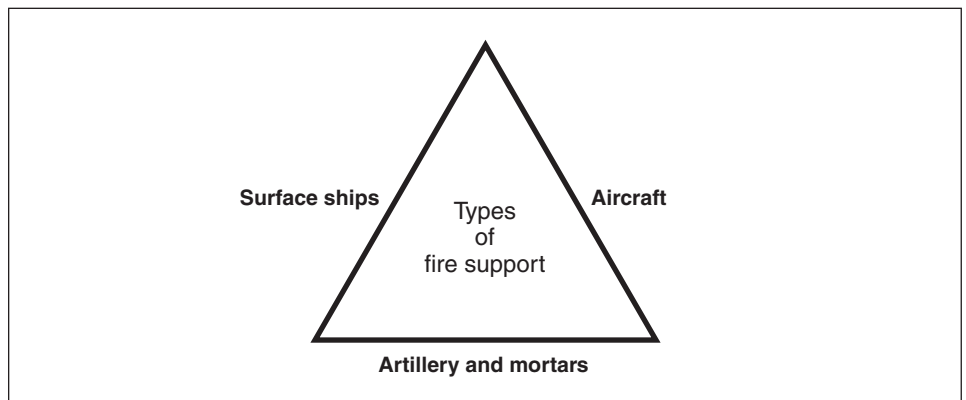
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## Background

The Marine Corps has been developing new concepts for expeditionary operations that are characterized by an increase in mobility, flexibility, and depth of operations. To successfully conduct these operations, the Marine Corps relies on a “fires triad” composed of land-based artillery and mortars, attack planes and helicopters, and sea-based surface ships to destroy or suppress enemy forces. Figure 1 shows the fires triad concept.

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**Figure 1: Fires Triad Illustration**



Source: GAO (presentation).

The systems within the fires triad are considered complementary. For example, while surface ships provide the majority of supporting fires for ground forces during the early phases of expeditionary operations, land-based artillery and mortars assume a greater role in later phases as more of these assets are placed ashore. Some legs of the triad offer capabilities others cannot. The guns of artillery and surface ships are more capable of providing volume of fire—large amounts of sustained fire to suppress or destroy a target—while aircraft are used for long-range precision strikes or attacks on moving targets. Regardless of each system’s capabilities or contributions, all components of the triad are considered necessary for success.

The sea-based portion of the triad is referred to as naval surface fire support and is traditionally provided by the guns and missiles onboard

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Navy surface ships. For decades the Navy had provided this capability with the 16-inch guns of the Iowa class battleships that were eventually taken out of service due to the high cost of their operations and maintenance. With the decommissioning of the last Iowa class battleship in 1992, the Navy was left with only the short-range (13 nautical miles<sup>2</sup>) 5-inch guns on destroyers and cruisers to provide naval surface fire support. According to the Navy, new and improved coastal defense systems deployed by potential adversaries required that Navy ships protect themselves by coming no closer than 25 nautical miles to shore, rendering the existing 5-inch guns ineffective for fire support. In May 1992, the Navy approved a mission need statement for naval surface fire support that recognized this gap in capabilities and called for new or improved systems that could provide increased range, lethality, and accuracy. Since that time, the Navy and Marine Corps have conducted a number of studies to identify possible solutions for this gap and to clarify the needs and requirements associated with naval surface fire support.

In 1994, the Navy developed a plan to improve naval surface fire support by upgrading existing 5-inch guns on *Arleigh Burke* class destroyers and *Ticonderoga* class cruisers and developing a new 5-inch guided munition for near-term capabilities, and considered options for long-term capabilities as it developed concepts for a new surface combatant ship. Eventually, these concepts evolved into the Extended Range Munition and the *Zumwalt* class destroyer programs. The establishment of basic requirements by the Marine Corps supported efforts to develop these systems. Marine Corps analysis concluded that since ground-based artillery would be unavailable during the initial stages of an expeditionary operation, naval surface fire support must provide, at a minimum, the same range, accuracy, and lethality as current artillery systems. In 1995, the Navy began to incorporate this analysis into its plans for acquiring new weapons systems by approving an initial range requirement of 41 to 63 nautical miles, assuming a 25 nautical mile stand-off range. As Marine Corps thinking on expeditionary operations evolved over the next decade, more requirements would be added.

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<sup>2</sup> A nautical mile is equal to about 1.85 kilometers.

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## Agreement on Requirements Took over a Decade and Did Not Address Quantitative Measures for Volume of Fire

For over 10 years the Marine Corps worked with the Navy to develop requirements for naval surface fire support that align with the concept of expeditionary operations. It was not until December 2005 that, as a result of the joint requirements process, an agreement was reached. This agreement provides the basis for meeting the fire support needs of the warfighter through a variety of solutions by attempting to define the effects required. One issue the agreement has not resolved is the lack of a clear definition for volume of fire. According to the Marine Corps, volume fires are necessary to execute expeditionary operations, but quantifiable volume fires requirements have not been established due to the variance in effects desired from mission to mission and the planned use of precision munitions. Clearer requirements would inform the acquisition of planned systems and aid in determining capabilities of any future systems.

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## Validated Requirements for Naval Surface Fire Support Are Derived from Marine Corps Concepts for Expeditionary Operations

Although the Marine Corps further defined its needs for naval surface fire support over the last 10 years, it only recently reached agreement with the Navy on a new set of requirements through the Joint Capabilities Integration and Development System, a joint process for establishing requirements. This process resulted in the *Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document*, which incorporated and validated the Marine Corps's requirements for naval surface fire support. These requirements are based on the concept of expeditionary operations that the service has been developing since 1992. Table 1 describes the documents and events central to creation of this concept.

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**Table 1: Basis for Evolving Requirements**

Year	Events
1992	<ul style="list-style-type: none"><li>• Gap in fire support left by decommissioning of battleships.</li><li>• Publication of <i>...from the Sea</i> shifts the emphasis of Marine Corps and Navy operations from confronting the Soviet threat at sea to the use of expeditionary forces in the littorals.</li></ul>
1994	<ul style="list-style-type: none"><li>• Navy completes first analysis of how to fill gap in naval surface fire support.</li><li>• Publication of <i>Forward...from the Sea</i> further refines Navy concept of expeditionary operations in the littorals.</li></ul>
1995	<ul style="list-style-type: none"><li>• Navy and Marine Corps agree to an initial range requirement of 41 to 63 nautical miles.</li></ul>
1996	<ul style="list-style-type: none"><li>• <i>Operational Maneuver from the Sea</i> presents Marine Corps concepts on expeditionary warfare including the reliance on sea-basing.</li><li>• First Marine Corps letter derives naval surface fire support requirements from concepts presented in <i>Operational Maneuver from the Sea</i>.</li></ul>
1997	<ul style="list-style-type: none"><li>• Publication of <i>Ship to Objective Maneuver</i> establishes the concept of multiple, independent maneuver forces attacking their targets directly instead of pausing to establish a foothold and attacking as a combined force.</li></ul>
1999	<ul style="list-style-type: none"><li>• Second Marine Corps letter on naval surface fire support requirements expands discussion of Marine Corps's needs.</li></ul>
2000	<ul style="list-style-type: none"><li>• Navy releases guidance on how ship design can support Marine Corps's requirements.</li></ul>
2001	<ul style="list-style-type: none"><li>• Marine Corps publishes <i>Expeditionary Maneuver Warfare</i> a capstone document that encapsulates and revalidates previous concepts and doctrine on expeditionary warfare.</li></ul>
2002	<ul style="list-style-type: none"><li>• Third Marine Corps letter on naval surface fire support requirements presents requirements across near-, mid-, and far-terms for evolutionary acquisition.</li></ul>
2003	<ul style="list-style-type: none"><li>• The Marine Corps drafts a memorandum of agreement on requirements, but Navy does not agree to memorandum.</li></ul>
2005	<ul style="list-style-type: none"><li>• Agreement reached on requirements for naval surface fire support.</li></ul>

Sources: Navy and Marine Corps (data); GAO (presentation).

According to the concept created by the Marine Corps, the fundamental aspect that defines expeditionary operations—sea-based forces operating with increased depth and mobility in multiple dispersed units—establishes certain requirements for naval surface fire support. Since land-based artillery is restricted by the need for a large presence ashore, and air-based fire support can be restricted by weather conditions, the importance of sea-based naval surface fire support increases. The depth of operations envisioned requires ship-based guns and other systems with considerable range, while the speed and mobility envisioned demand rapid response times. Fire support for expeditionary forces also requires accuracy and precision, to increase the probability that targets are destroyed or disabled and reduce the possibility of marines being killed when calling for munitions to land close to their own positions. Sustainability and lethality are needed as well to compensate for the firepower removed from Marine units to preserve their speed and agility. According to the Marine Corps, volume of fire, defined as large quantities of munitions delivered over time

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or simultaneously to suppress or destroy a target, is also necessary to immobilize or destroy the enemy and enable maneuver. These requirements surpass the abilities of the Navy's existing 13 nautical mile range 5-inch guns, necessitating the development and fielding of new weapons systems or the acceptance of risks in executing expeditionary operations.

The Marine Corps quantified many of the requirements for naval surface fire support to better communicate them to the Navy and aid in the development of new systems. While an initial range requirement was established in 1995, the Marine Corps identified a number of additional requirements for naval surface fire support that clarify the needs for expeditionary operations. These requirements were identified in a series of three letters from 1996 to 2002, with the last letter describing requirements in terms of desired near-, mid-, and far-term capabilities. The Marine Corps also provided rationale for its needs by providing an explanation of each of the requirements. Table 2 lists the requirements as described in the last of these letters. The Marine Corps sought to use these letters to establish a more formal agreement on the needs for naval surface fire support, and even drafted a memorandum of agreement in 2003. While the Navy did not sign this memorandum, many of the requirements presented in the letters were used in the development of systems and technologies to provide fire support. Agreement was reached when the Joint Requirements Oversight Council, which oversees requirements development for all four services, approved *the Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document* in December 2005. This document incorporated and validated Marine Corps requirements for naval surface fire support.

**Table 2: Naval Surface Fire Support Requirements**

		<b>Near-Term (2004-2005)</b>	<b>Mid-Term (2006-2009)</b>	<b>Far-Term (2010-2019)</b>
System response	Threshold <sup>a</sup>	2.5 minutes	2.5 minutes	2.5 minutes
	Objective	Limits of technology	Limits of technology	Limits of technology
Range: naval guns	Threshold	41 nm	63 nm	97 nm
	Objective	63 nm	97 nm	Limits of technology
Range: other systems	Threshold	200 nm	200 nm	262 nm
	Objective	222 nm	222 nm	Limits of technology
Accuracy and precision	Threshold	50 m CEP <sup>b</sup>	50 m CEP	50 m CEP
	Objective	20 m CEP	20 m CEP	20 m CEP
Target acquisition	Threshold	50 nm	63 nm	97 nm
	Objective	63 nm	97 nm	Limits of technology
Ordnance effects	<ul style="list-style-type: none"> <li>• Destroy or suppress point, area, and moving targets including personnel and material, and destroy hardened targets</li> <li>• Provide smoke, illumination, and incendiary effects</li> </ul>			
Volume of fire	<ul style="list-style-type: none"> <li>• Volume fires are equally important to precision</li> <li>• Needed for mass fires, suppression, combined arms effects, and close fire support</li> <li>• Sufficient quantities are maintained to sustain desired effects over time</li> </ul>			
Sustainment	<ul style="list-style-type: none"> <li>• All systems sustainable via under way replenishment</li> </ul>			

Source: Marine Corps.

Note: As defined by Marine Corps March 2002 "Hanlon Letter" and approved by the Joint Requirements Oversight Council in December 2005.

<sup>a</sup>Threshold refers to minimally acceptable performance and objective refers to desired performance.

<sup>b</sup>Circular error probable.

## Requirements for Volume of Fire Remain Unclear

While some of the Marine Corps requirements for naval surface fire support have been quantified, validated, and applied to Navy systems in development, the requirement for volume of fire remains less defined. The Marine Corps has consistently maintained the need for these fires and has described their use under the concept of expeditionary operations. The Marine Corps defines volume of fire as large quantities of munitions delivered over time or simultaneously to suppress or destroy a target. This definition establishes two types of volume fires: suppression, which requires a large quantity of munitions delivered on a target or group of targets in an area over a period of time, and destruction, where a large quantity of munitions are delivered simultaneously with as much accuracy as possible. Marine Corps officials have also identified an increasing need for multiple simultaneous suppression or destruction missions to support

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dispersed units. While the Marine Corps's letters on naval surface fire support provide definitions of these missions, the requirements provided do not offer quantitative measures of effectiveness or success for all the key elements of volume of fire. The firing rate of weapon systems and their ability to deliver multiple rounds simultaneously are highlighted as important, but other factors—such as the amount of time or munitions typically required for suppression, or the number of simultaneous engagements to be supported—remain undefined.

Marine Corps and Navy officials have stated that the advent of precision munitions for naval surface fire support further complicates requirements and definitions for volume of fire. Currently, volume fires are provided by ground-based artillery and mortars firing large amounts of inexpensive, unguided munitions. Due to the perceived benefits of precision in air-delivered weapons and the need to deliver naval surface fire support from greater distances due to shore-based threats, the Navy has been developing guided munitions for fire support. These munitions have the potential to deliver far greater precision and lethality than unguided munitions, but the high cost of procurement—up to \$54,500 per round for the Extended Range Munition against \$1,633 for the current 5-inch projectile<sup>3</sup>—could preclude the Navy from deploying them in the large quantities posited for volume fires. Marine Corps officials have stated that the concept of providing volume of fire with precision munitions is currently being analyzed and that changes to the way volume fires are employed could be possible. For instance, as the lethality and precision of munitions increase, it may be possible to change the way targets are selected and use fewer rounds to achieve volume effects. Officials state, however, that there are still scenarios in which large sustained quantities of munitions are necessary.

The ambiguity surrounding volume of fire, especially when such missions are executed with precision weapons, has a direct impact on the procurement of munitions for naval surface fire support. The Navy uses an estimating process, known as the non-nuclear ordnance requirements process, to assist in determining the number of munitions needed to support the warfighter. According to Navy officials, to accurately estimate the number of rounds needed for volume fires the model requires—but does not have—a definition of the effects desired from volume fires. In

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<sup>3</sup> The \$1,633 represents the fiscal year 2008 price of the Navy's unguided 5-inch high explosive projectile and its propelling charge.



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addition, the process does not currently account for the new capabilities offered by the precision weapons under development for naval fires. Without the Marine Corps's definition of these effects, the model will produce inaccurate or unrealistic estimates of the number of rounds needed. Navy officials identified other shortcomings in both the information provided by the Navy and Marine Corps and in the assumptions used to model naval surface fire support procurement quantities. For instance, the model does not provide enough fidelity in the distance to targets or properly account for the number of precision rounds carried in each ship. The Marine Corps, through the Expeditionary Warfare Division in the Office of the Chief of Naval Operations, is working with the Navy to refine the data provided to the non-nuclear ordnance requirements process as well as the assumptions made within the process itself.

The inability to quantify requirements for volume of fire also affects the ability of the Navy to develop systems to meet the Marine Corps's needs. The Marine Corps has stated that the effects desired from volume of fire varies from mission to mission and therefore is difficult to quantify. However, the variance in desired effects from scenario to scenario is a challenge in other warfare areas as well. In the absence of requirements that define at least minimum capabilities for common scenarios, such as the duration and quantity of fire needed to suppress a target, it may be difficult to develop cost effective systems that meet Marine Corps needs.

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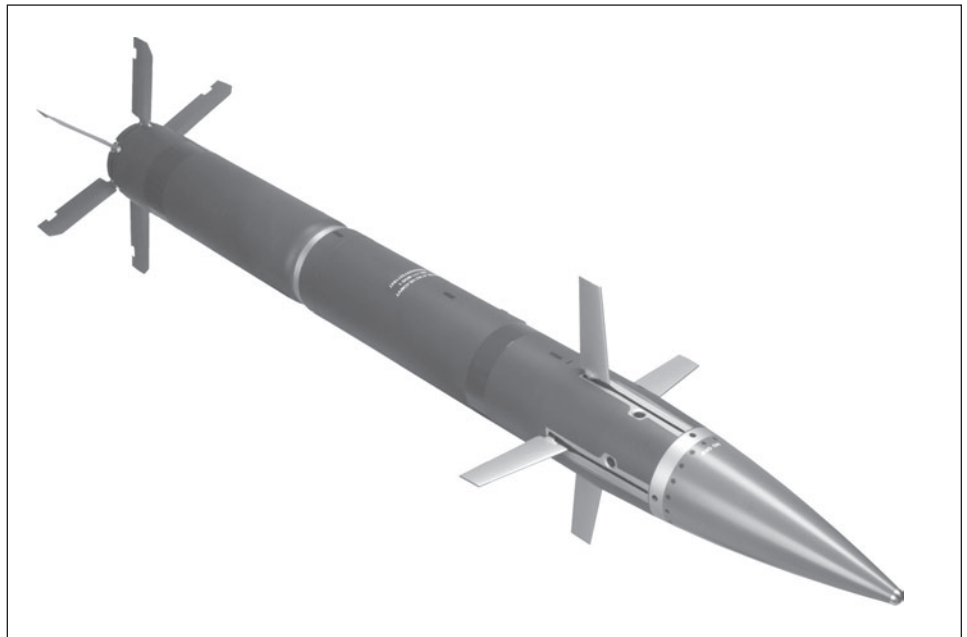
## Naval Surface Fire Support Systems Have Experienced Cost and Schedule Growth and Will Deliver Less Capability Than Originally Planned

The Extended Range Munition and *Zumwalt* class destroyer have required additional funding and time for development and will not be fielded in the quantities initially planned. Development of the Extended Range Munition has been delayed by nearly 11 years due to technical and programmatic challenges, resulting in cost growth of over 550 percent from initial estimates. The Navy continues to face challenges related to the affordability and viability of its plan ahead that must be overcome in order to field the munition. Optimistic estimates and consequent cost increases in the *Zumwalt* class destroyer program have resulted in reductions to both ship quantities and munition capacities per ship, both of which will seriously impact capabilities available to support future expeditionary operations. Candidate technologies to provide future naval surface fire support capabilities are currently in development as science and technology programs, and have not yet completed the requirements documentation and other steps necessary to enter the acquisition process.

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## The Extended Range Muniton Has Experienced Cost Overruns and Schedule Delays and Continues to Face Risk

**Figure 2: Extended Range Muniton**



Source: Raytheon, © 2006 Raytheon.

After 10 years in development, the Extended Range Muniton continues to experience challenges with technology and design, which could jeopardize near term capabilities for naval surface fire support.

The Extended Range Muniton is a precision guided muniton fired from a modified 5-inch gun and is designed to provide accurate fire support for ground forces to an objective range of 63 nautical miles. In order to fire the muniton, elements of the existing 5-inch gun design including the gun barrel, magazine, ammunition handling, and gun initialization systems were modified. In addition to changes in the gun, the Navy has also developed a naval fires control system, which will be used to receive, process, and execute warfighter fire mission requests for the gun system. The Navy is installing the modified 5-inch guns, each with a magazine capacity of 232 Extended Range Muniton rounds, and fires control systems onboard 32 Arleigh Burke class destroyers (DDG 81 through DDG 112), but has abandoned plans to equip 22 Ticonderoga class cruisers with all the capabilities needed to fire the new munitions. Table 3 summarizes major events that have occurred in the Extended Range Muniton program.

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**Table 3: Major Events in the Acquisition of the Extended Range Munition**

Year	Events
1996	<ul style="list-style-type: none"><li>• Operational requirements for an extended range munition are approved that reflect Marine Corps range and accuracy needs.</li><li>• Program begins with system design and demonstration as opposed to concept and technology development.</li><li>• Navy contracts with Texas Instruments in Dallas, Texas, for development and testing of a 5-inch precision munition.</li></ul>
1997	<ul style="list-style-type: none"><li>• Raytheon acquires Texas Instruments.</li></ul>
1999	<ul style="list-style-type: none"><li>• Raytheon relocates development of the program to Tucson, Arizona, resulting in workforce disruption and delays.</li><li>• Design of components changes as contractor learns effects of fluctuating pressures subjected to the munition when fired.</li></ul>
2001	<ul style="list-style-type: none"><li>• Planned initial operating capability not achieved; currently planned for 2011.</li></ul>
2002	<ul style="list-style-type: none"><li>• Navy alters requirements triggering a change from submunition to unitary warhead.</li><li>• Redesign continues.</li></ul>
2003	<ul style="list-style-type: none"><li>• Critical design review completed based on design of developmental test rounds—design of production ready munition remains incomplete.</li><li>• Land-Based Flight Test 1 fails due to guidance and tail fin issues.</li><li>• Gun environment instability continues until gun pressures are stabilized in 2004.</li></ul>
2004	<ul style="list-style-type: none"><li>• Navy partially halts work on the program due to budget, schedule, and performance issues.</li><li>• Navy awards second, separate demonstration contract for an alternate munition and discusses a competition for future contracts.</li><li>• Navy partially restarts the program for work in specific areas.</li></ul>
2005	<ul style="list-style-type: none"><li>• Engineering Flight Test A succeeds in demonstrating launch and guided flight of the munition.</li><li>• Engineering Flight Test B fails due to an issue with the guidance system.</li><li>• Land-Based Flight Test 2 fails due to canard and rocket motor issues.</li><li>• Land-Based Flight Test 3 fails due to a manufacturing issue.</li><li>• Land-Based Flight Tests 4 and 6 fail due to canard issues.</li><li>• Land-Based Flight Test 5 succeeds in demonstrating launch and guided flight of the munition.</li><li>• Proposed munition quantities increase with Marine Corps involvement.</li></ul>
2006	<ul style="list-style-type: none"><li>• Navy ceases funding for alternate munition due to test failures—effort continues through funding added by Congress.</li><li>• Program costs trigger a change in acquisition category resulting in a shift in oversight to Undersecretary of Defense for Acquisition, Technology, and Logistics.</li></ul>

Sources: Contractor and Navy (data); GAO (presentation).

Despite the progress on the gun and fire control systems, development of the munition has been more challenging than initially anticipated. When the program began in 1996, the Navy planned to use several components from the previously developed 5-inch semi-active laser guided projectile

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and assumed that few changes to these components were necessary. Navy officials then approved an accelerated schedule that began directly with development and demonstration of the system design.<sup>4</sup> In the late 1990's, the program began to experience technical problems with the explosive used to propel the munition from the gun, resulting in damage to munition components. These problems resulted in the need to redesign certain components. Additional design changes occurred in 2002 when warhead requirements were altered by the Navy. Although work on the program was partially halted from February to May 2004 due to poor testing performance and cost and schedule growth, the contractor continued to redesign components in several areas, such as the rocket motor, tail fins, and guidance system, in order to improve performance. After redesign of individual munition components, testing of the munition resumed. Beginning in February 2005, the contractor sought to demonstrate the munition's reliability through a series of seven land-based flight tests. Five of these tests failed due to component issues; two of these failures have been traced to a lack of quality controls with suppliers.

The Navy's decision to accelerate the program's schedule by entering directly into system design and demonstration increased cost and schedule risk in the munition's development. Our work on best practices has shown that a critical first step in developing systems is to fully demonstrate technologies before system development begins, thereby reducing program risk and creating confidence that technologies will work as expected.<sup>5</sup> The Navy chose to accept this technical and design risk by allowing the Extended Range Munition to enter system design directly. Since a knowledge-based process was not effectively utilized early in the program, the Navy could not provide an accurate estimate for the resources needed for development.

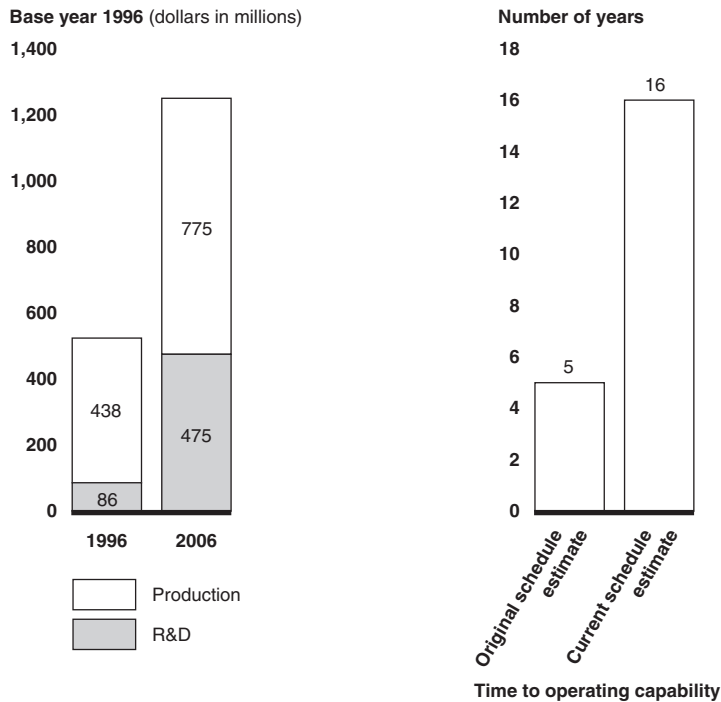
Challenges to date have resulted in schedule delays and significant cost growth. Figure 3 shows the total estimated cost and schedule growth in the program since 1996.

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<sup>4</sup> The Defense Department's framework for managing acquisition programs, presented in DOD Instruction 5000.2, establishes 5 program phases: concept refinement, technology demonstration, system development and demonstration, production and deployment, and operations and support. A program may be authorized to enter into the acquisition system at any point consistent with phase specific entrance criteria and statutory requirements.

<sup>5</sup> For more information see GAO, *Best Practices: Better Management of Technology Development Can Improve Weapon Systems Outcomes*, [GAO/NSIAD-99-162](#) (Washington, DC: July 30, 1999).

**Figure 3: Cost and Schedule Growth in the Extended Range Muniton Program**



Source: Navy (data), GAO (presentation).

The Navy originally estimated that development of the muniton would require \$86 million. Currently, the Navy projects that development will require a total of \$475 million.<sup>6</sup> Increases in production costs are due in part to a decision to increase procurement of the muniton from 8,500 rounds to 15,000 rounds. In August 2006, oversight of the program was elevated by requiring that major programmatic decisions, such as approval of the Navy's estimate for resources needed for completion and the strategy for development and testing, be approved by the Undersecretary of Defense for Acquisition, Technology, and Logistics rather than the Navy. While this restructuring has elevated oversight, a comprehensive review of the program by the Undersecretary has not been performed.

As a result of challenges in developing the muniton, the Navy sought possible alternatives to the Extended Range Muniton and awarded a second, separate demonstration contract in May 2004 for the Ballistic

<sup>6</sup> All amounts shown as base year 1996 dollars.

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Trajectory Extended Range Munition. The munition's rocket motor caused test failures and led the Navy to conclude that any further efforts to develop the munition for competition would not be worthwhile. According to a Navy official, the Navy concluded that the Extended Range Munition was a more viable option for fielding a tactical round by fiscal year 2011 and is no longer requesting funding for the Ballistic Trajectory Extended Range Munition. Instead, the Navy has chosen to modify the current contract and continue development of the Extended Range Munition. Navy officials state a competition could still occur in 2011 for production of the Extended Range Munition.

While the Navy intends to begin fielding the Extended Range Munition in 2011, major risks remain. The program faces technical challenges in demonstrating the munition's guidance components as well as successfully completing component testing and ensuring reliability of the munition. Even though the program had two successful land-based tests in 2005, the Navy has yet to repeat such demonstrations and does not plan to begin shipboard testing until 2010. The Navy currently plans to conduct 40 land-based guided flight tests prior to the shipboard event. According to program officials, the Navy continues to evaluate plans and identify resources required for completing development of the munition. Program officials are considering alternative plans for testing the munition's reliability through additional component and land-based flight tests. Until these plans are completed and approved through a comprehensive review by the Undersecretary of Defense for Acquisition, Technology, and Logistics, uncertainty remains on whether the Navy's revised strategy follows a knowledge-based approach and aligns the program's available resources with the Navy's goal to begin fielding in 2011.

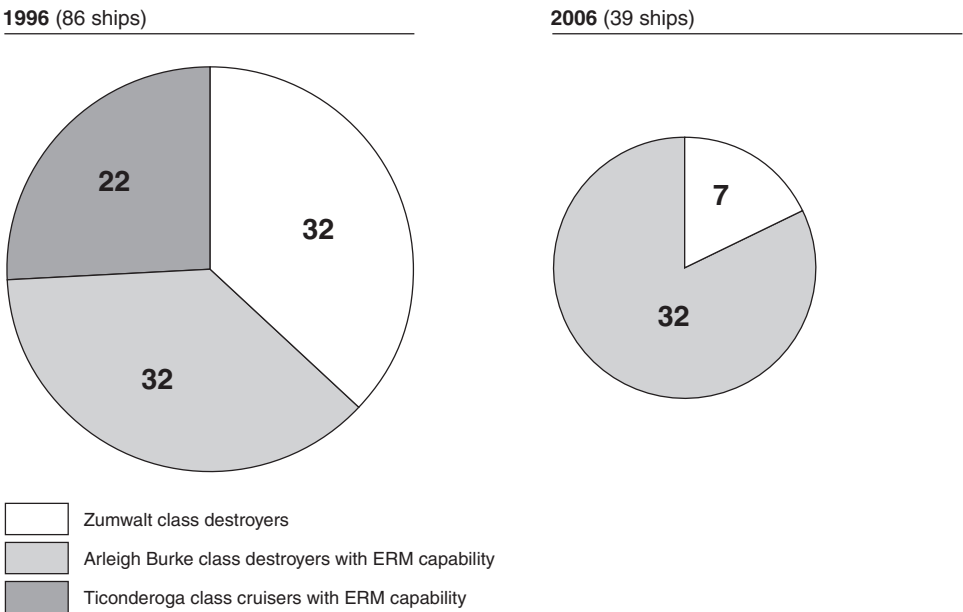
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**Affordability Concerns in the *Zumwalt* Class Destroyer Program Have Led to Reductions in Naval Surface Fire Support Capabilities and Procurement Quantities**

The *Zumwalt* class destroyer will deliver far fewer quantities of ships and munitions for naval surface fire support than envisioned 10 years ago. The primary reason for this reduced capability is that the Navy's concept for the *Zumwalt* class destroyer promised revolutionary performance at an unrealistically low cost. In 2001, the Department of Defense recognized that additional time and money were required to develop and field the destroyer and concluded that a new approach was necessary. Through a series of decisions, the Navy restructured the program by adding time for technology development, trading naval surface fire support capability for lower costs, and reducing the planned number of ships. At the same time, other ship capabilities were maintained or even expanded, leading to increased cost and additional technical risk. The capability trades and quantity reductions in the *Zumwalt* class destroyer program increase the

Navy’s dependence on the less capable Extended Range Mmunition (ERM) to provide naval surface fire support, as shown in figure 4.<sup>7</sup>

**Figure 4: Reductions to Ship Quantities Planned for Naval Surface Fire Support**



Source: Navy (data), GAO (presentation).

The *Zumwalt* class destroyer program represents the Navy’s solution for addressing a mission need identified in 1994 for a 21st century surface combatant capable of, among other things, projecting sustained naval surface fire support for amphibious and other ground forces. The program was derived from a concept for a tailored capability ship identified as the Maritime Fire Support Ship. This concept featured significant naval fires capabilities—including two advanced 155 millimeter gun systems capable

<sup>7</sup> The Department of Defense notes that the *Zumwalt* class destroyer’s planned capacity for land attack munitions—and its ability to replenish munitions while underway—offered sufficient capability to meet current programmatic and operational requirements for naval surface fire support. While the ship may meet requirements as they are currently stated, decreases to munition capacity on the order of 50 percent—especially when coupled with ship quantity reductions from 32 to 7—lessen the contribution of the *Zumwalt* class destroyer in performing naval surface fire support and result in a greater reliance on other fire support systems.

of firing a land attack munition up to 100 nautical miles—as well as robust surface and subsurface warfare capabilities, reduced signatures, and reduced crewing compared to that of current ship classes. The Navy used the characteristics of the Maritime Fire Support Ship to serve as a basis for developing requirements for the DD 21 land attack destroyer. These requirements were approved by the Joint Requirements Oversight Council in 1997 and featured robust capabilities related to naval surface fire support including threshold quantities of 2 advanced gun systems, 1200 munitions capable of long range land attack, and 128 missile launch cells. When sized to these capabilities, DD 21 was expected to displace over 17,000 long tons. Requirements also included ambitious targets for reduced manning and a low radar cross section. DD 21 plans, along with other Zumwalt class program events, are shown in table 4.

**Table 4: Major Events in the Acquisition of the Zumwalt Class Destroyer**

Year	Event
1994	<ul style="list-style-type: none"> <li>Navy identifies need for a new 21st century surface combatant (SC 21) to provide naval surface fire support.</li> </ul>
1997	<ul style="list-style-type: none"> <li>Analysis for SC 21 found that using a family of ships—as opposed to one ship—built on a common hull offered advantages.</li> <li>Navy approves minimum requirements for DD 21 including 2 advanced gun systems, 1200 land attack munitions, and 128 missile cells.</li> <li>Plans for DD 21 include 32 ships with an average unit cost not to exceed \$921 million (FY96\$) and an initial operational capability of fiscal year 2008 (Acquisition Program Baseline – January 1998).</li> </ul>
1999	<ul style="list-style-type: none"> <li>DD 21 program costs increase to account for development of software and key systems including the volume search radar, advanced gun system, and integrated power system.</li> <li>DD 21 program plans revised to include 32 ships with an average unit cost not to exceed \$956 million (FY96\$) (Acquisition Program Baseline – March 1999).</li> </ul>
2001	<ul style="list-style-type: none"> <li>DD 21 program restructured to emphasize technology development and affordability.</li> <li>Program renamed DD(X) and designated within a family of future surface combatants including a future cruiser and littoral combat ship.</li> </ul>
2002	<ul style="list-style-type: none"> <li>Marine Corps releases a memorandum with a requirement for each DD(X) to be equipped with 2 advanced gun systems and 900 to 1200 land attack munitions.</li> <li>Navy completes its review of requirements for future surface combatants and recommends a force structure of 16 DD(X) each with 2 advanced gun systems, 900 land attack munitions, and 96 missile cells.</li> <li>Navy recognizes the need for an additional \$7.6 billion to complete DD(X) technology development, testing, and evaluation efforts.</li> </ul>
2003	<ul style="list-style-type: none"> <li>Chief of Naval Operations directs that DD(X) capabilities include 2 advanced gun systems, 600 land attack munitions, and a minimum of 80 missile cells.</li> <li>Navy modifies DD(X) radar design, increasing air defense capability while adding development risk.</li> </ul>



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Year	Event
2004	<ul style="list-style-type: none"><li>• DD(X) program restructured to include a quantity of 8 ships, an average unit cost not to exceed \$2.6 billion (FY96\$), and an initial operational capability of fiscal year 2013 (Acquisition Program Baseline—April 2004).</li><li>• DD(X) operational requirements approved which reflect minimum naval surface fire support capabilities outlined by the Chief of Naval Operations in June 2003 and incorporate the Marine Corps requirements for range, accuracy, and system response time.</li></ul>
2005	<ul style="list-style-type: none"><li>• Navy approves a DD(X) system design, which includes 2 advanced gun systems with 300 rounds each, a convertible storeroom capable of holding an additional 320 land attack munitions, and 80 missile cells.</li><li>• Navy approves new plans for the DD(X) program including a procurement quantity of 10 ships, an average unit cost not to exceed \$3.1 billion (FY96\$), and an initial operational capability of fiscal year 2014 (Acquisition Program Baseline—November 2005).</li><li>• Undersecretary of Defense for Acquisition, Technology &amp; Logistics authorizes detail design and construction of 8 ships.</li><li>• Navy pursues further cost reductions and eliminates the 320 round capable convertible storeroom, saving approximately \$19 million in procurement costs per ship.</li></ul>
2006	<ul style="list-style-type: none"><li>• Navy outlines its 30 year shipbuilding plan in a report to Congress, which identifies plans to construct 7 DD(X) destroyers.</li><li>• DD(X) program renamed DDG 1000 Zumwalt class destroyer.</li><li>• Congress authorizes split funding of two lead ships but states that procurement costs for the two ships should not rise above \$6.528 billion.</li></ul>

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Sources: Navy (data); GAO (presentation).

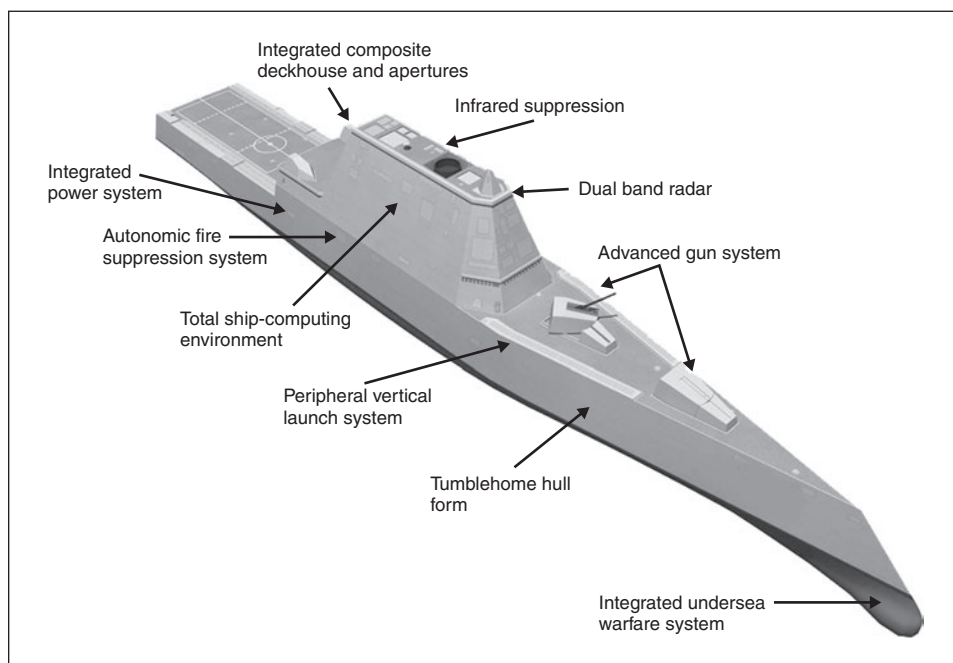
In 2001, the Office of the Secretary of Defense developed concerns that the program's cost estimate was unrealistic and that the program was not adequately funded.<sup>8</sup> Although originally envisioned as a tailored capability ship, DD 21 requirements outlined a multimission ship featuring several revolutionary technologies. These concerns prompted the Navy to restructure the program and revisit its planned family of ships concept. As a result, the Navy revised its family of ships approach to include a future destroyer named DD(X), a future cruiser known as CG(X), and a new littoral combat ship. This approach sought to take advantage of commonality among the three programs in an effort to mitigate risk in

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<sup>8</sup> Since 2001, the Navy has taken some actions to improve the realism of cost estimates, although we have also reported on additional measures the Navy could take. See GAO, *Defense Acquisitions: Challenges Associated with the Navy's Long-Range Shipbuilding Plan*, [GAO-06-587T](#) (Washington, D.C.: Mar. 30, 2006) and GAO, *Defense Acquisitions: Improved Management Practices Could Help Minimize Cost Growth in Navy Shipbuilding Programs*, [GAO-05-183](#) (Washington, D.C.: Feb. 28, 2005).

technology development.<sup>9</sup> Figure 5 shows the different technologies introduced through the DD 21 and DD(X) programs.

**Figure 5: Advanced Technologies on the Zumwalt Class Guided Missile Destroyer**



Source: Navy (data), GAO (presentation).

The DD 21 and DD(X) programs introduced several revolutionary technologies, many of which remain in development.

The Navy's Surface Combatant Spiral Development Review in 2002 recommended a multimission DD(X) configured with 2 advanced gun systems, 900 land attack munitions, and 96 missile launch cells as the most cost-effective basis for developing DD(X) requirements. These capability reductions were expected to decrease the ship's cost by reducing the destroyer's weight from nearly 17,000 long tons expected for DD 21 to approximately 15,700 long tons. Subsequently, the Chief of Naval Operations directed that the size of DD(X) be reduced to 14,000 long tons while retaining multimission capability. To achieve these goals, the Navy

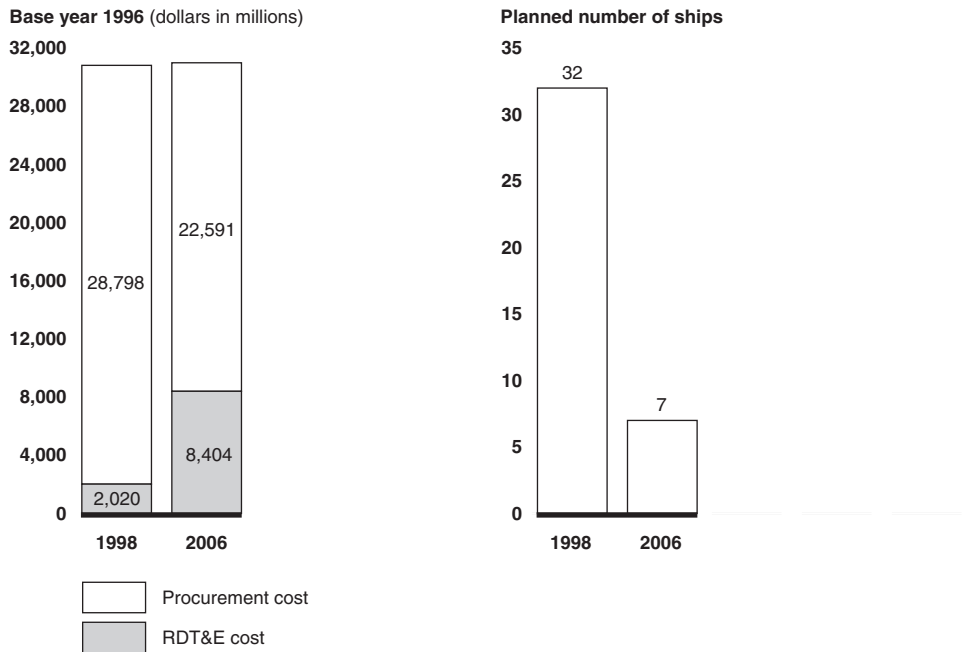
<sup>9</sup> For more information on Zumwalt class destroyer technology development, see GAO, *Progress of the DD(X) Destroyer Program*, [GAO-05-752R](#) (Washington, D.C.: June 14, 2005) and GAO, *Defense Acquisitions: Challenges Facing the DD(X) Destroyer Program*, [GAO-04-973](#) (Washington, D.C.: September 3, 2004).

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reduced planned DD(X) land attack munitions to 600 and decreased minimum requirements for missile launch cells to 80 per ship. In an effort to address Marine Corps concerns regarding the reduced naval surface fire support capabilities offered by DD(X) as compared to DD 21, the Navy modified the DD(X) design to include a convertible storeroom capable of holding an additional 320 land attack munitions. The Chief of Naval Operations also directed the Navy to revisit its plan for developing a volume search radar for the DD(X) design. According to Navy officials, undertaking development of a less technologically mature, but potentially more powerful volume search radar for DD(X) was worthwhile because it would help preserve a competitive industrial base in advance of CG(X) development. The change would also add air defense capability to DD(X), giving the ship capability that exceeds performance requirements. Achieving these benefits, however, would require the Navy to delay testing for the volume search radar and commit nearly \$20 million in additional research, development, test, and evaluation funding for the DD(X) program to manage the significant technical risk associated with developing the more challenging technology. One month following the Chief of Naval Operations's directive, the Navy modified the ship's radar development contract to accommodate the higher risk volume search radar approach.

In 2004, the Department of Defense approved new program goals and operational requirements for the DD(X) program that reflected a plan to procure fewer ships, projecting less naval surface fire support capability than DD 21. Figure 6 shows how program costs and quantities have changed over time.

**Figure 6: Cost and Quantity Change in the Zumwalt Class Destroyer Program**



Source: Navy (data), GAO (presentation).

Continuing cost pressures in the program led the Navy to reevaluate DD(X) capabilities, technologies, and design as part of a comprehensive cost reduction effort. As part of this effort, the Navy eliminated the DD(X) convertible storeroom from the ship's design. Although yielding approximately \$19 million in procurement savings per ship, this decision reduced the ship's naval surface fire support capability by almost 35 percent. Other DD(X) capabilities and technologies including the ship's dual band radar (volume search radar and multifunction radar), integrated computing environment, and reduced signature features were not significantly affected during this process. According to Navy officials, contractor estimates have identified \$265 million in procurement savings achieved for each *Zumwalt* class destroyer.

In 2006, the Navy changed the name of the DD(X) program to DDG 1000 *Zumwalt* class destroyer and reduced planned ship quantities to 7. Although this decision reflected the practical realities of recognizing more realistic costs, these reductions nevertheless increase the Navy's reliance on successful outcomes in the Extended Range Mmunition program in order to complete future naval surface fire support missions. This reliance is further compounded by Navy decisions that have reduced the number of

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land attack munitions each Zumwalt class ship is capable of carrying. However, because the Extended Range Mmunition offers less range and capability than the DD(X) long-range land attack munition, the Navy may be forced to accept additional risk in certain fire support missions. Currently, the Navy plans to field the Extended Range Mmunition on 32 *Arleigh Burke* class destroyers, which will be supplemented with 7 *Zumwalt* class ships carrying long-range land-attack munitions.

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### Navy Has Begun Development of Some Candidate Systems for Future Naval Surface Fire Support Capabilities

The Navy has begun science and technology efforts for the electromagnetic railgun and multipurpose loitering missile, but has not approved development or fielding of these systems as formal acquisition programs. The Office of Naval Research is leading efforts to develop and test a prototype of the electromagnetic railgun and estimates that the system will require approximately \$216 million to complete its initial demonstration phase in support of fielding around 2025. The electromagnetic railgun is one of four key naval prototype efforts within the Office of Naval Research, which together represent 50 percent of the agency's fiscal year 2007 proposed investment in leap-ahead innovations.

Naval Sea Systems Command is managing preliminary tests and the development effort of the Affordable Weapon System, which is one candidate for the multipurpose loitering missile concept. The project has received approximately \$155 million to date in support of these efforts. While neither the electromagnetic railgun nor the multipurpose loitering missile have been formally chosen as programs for acquisition, these systems provide the Navy and Marine Corps with potential options for future naval surface fire support capabilities. Further analysis by the Navy and the Department of Defense will determine whether these technologies are feasible and if these systems are needed.

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### Needs for Naval Surface Fire Support Exceed Projected Capabilities

Based on the 2005 *Initial Capabilities Document for Joint Fires in Support of Expeditionary Operations in the Littorals*, the Extended Range Mmunition and Zumwalt class destroyer will not provide the full range of capabilities needed for naval surface fire support. Analysis performed for the initial capabilities document studied the capabilities of systems across the services to provide fire support in the littorals and identified 4 capability gaps—command and control of joint fires, engaging moving targets, minimized collateral damage, and achieving volume fires effects. While the Navy has initiated efforts to address remaining naval surface fire support needs, it faces challenges in further defining requirements for volume of fire, shaping acquisition outcomes to meet the

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needs of the expeditionary warfighter, and managing command and control issues related to fire support.

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**Extended Range Munition and *Zumwalt* Class Destroyer Offer Significant Naval Surface Fire Support Capability, but Cannot Meet All the Needs of Future Warfighters**

In December 2005, the Joint Requirements Oversight Council reviewed and validated the *Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document*, which describes some of the fire support needs of the warfighter for the next decade as well as the gaps that exist in meeting these needs. Needs were defined by collecting guidance, tasks, conditions, and standards for fire support from each of the services, including those presented by the Marine Corps's letters on naval surface fire support. Gaps in capability were identified by analyzing the ability of current and planned systems throughout the fires triad, including the Extended Range Munition and *Zumwalt* class destroyer, to fulfill the defined needs. As could be expected from any analysis of current versus desired capabilities, the initial capabilities document identified a number of gaps. The document lists the gaps in order of priority as 1) the ability to transmit and receive targeting information to enable command and control of fire support, 2) engaging moving targets in poor weather, 3) providing fire support when collateral damage or casualties in friendly forces is a concern, and 4) providing volume fires to achieve suppression of enemy targets.

While the initial capabilities document approaches fire support needs and capabilities from a joint perspective—meaning that the need for fire support and the systems providing it can come from the Navy, Marine Corps, Army, or Air Force—it does address naval surface fire support systems specifically. The Extended Range Munition and *Zumwalt* class destroyer were treated as planned systems within the analysis, as they are expected to become available within the 2005 to 2015 time period considered in the study. The analysis conducted for the initial capabilities document revealed that if these systems are implemented as currently planned they will provide the warfighter with improved capabilities to engage certain targets, especially in restricted conditions such as poor weather. However, they do not provide enough additional capability to close any of the four gaps. Future systems for naval surface fire support, such as the electromagnetic rail gun and the multipurpose loitering missile, were not considered as they will not be available until after 2015.

The analysis performed for the initial capabilities document discussed a number of weaknesses in current and planned naval surface fire support systems. For instance, the analysis determined that Navy ships cannot take full advantage of targeting information communicated from other systems

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affecting their ability to provide accurate fire support, especially when collateral damage is a concern. Munitions currently in use or development also lack the ability to hit moving targets, as they have neither the sensors to detect moving targets nor the ability to update the location of targets while in flight. The need for volume fires is not fully met by the Extended Range Munition and *Zumwalt* class destroyer either, and multiple, simultaneous calls for volume fire provide a challenge as well. Officials state that this gap in volume of fire persists despite the low number of calls for suppression anticipated by the analysis—5 targets or 0.3 percent of the total fires called for in the scenarios analyzed—due to the reductions made in munitions available for naval surface fire support and uncertainty about the effects expected.

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## Risks Remain in the Navy's Approach for Addressing Future Needs in Naval Surface Fire Support

### Requirements for Volume of Fires Need Further Definition

The *Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document* provides greater definition for volume of fire than articulated in earlier Marine Corps's correspondence on naval surface fire support, presenting new measures of effectiveness for suppression. The document establishes a minimum capability needed to fill the gap in volume fires for suppression that includes measures of effectiveness for probability of damage against targets and a number of targets to suppress as well as capabilities like range and rate of fire. However, these desired minimum capabilities still lack a measure for the duration of fire, or how long targets need to be suppressed or fired upon to cause the stated amount of damage, and the amount of munitions needed to cause these effects. Instead of providing measures for these capabilities, the document reiterates previous analyses by stating that more specific volume requirements are dependant on the situation. Initial capabilities documents, like the *Joint Fires* document, do not generally establish requirements but only suggest capabilities. A set of requirements that quantitatively captures all the capabilities potentially needed is a necessary precursor for the Department of Defense to determine whether and how to address any resultant capability gap regarding volume fires.

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Current Navy Practices for  
Managing Resources and  
Requirements Increase Risk  
That Warfighter Needs Will Go  
Unaddressed

Navy processes for defining requirements and allocating resources for naval surface fire support systems may result in acquisition outcomes that do not align with the priorities of the expeditionary warfighter. The Navy's Expeditionary Warfare Division is charged with developing capabilities and requirements for naval surface fire support. However, this division has not had a formal oversight role in the Extended Range Munion and Zumwalt class destroyer programs. Instead, the Navy has assigned management of requirements and resources for these programs to its Surface Warfare division, which is charged with developing capabilities and requirements for destroyers and other surface ships.<sup>10</sup> This approach places the Navy at risk for making investment decisions in its naval surface fire support programs without fully understanding the potential impacts on operating concepts for expeditionary warfare.

For example, quantity requirements in the Extended Range Munion program were initially established by the Navy's Surface Warfare Division. However, a 2005 report from the Department of Defense's Office of the Inspector General identified the Navy's Expeditionary Warfare Division as responsible for both analyzing warfighting requirements for the Extended Range Munion and validating planned procurement quantities in the program. On the basis of the Inspector General's report the planned quantities of the Extended Range Munion increased by over 75 percent in order to meet Marine Corps naval surface fire support requirements. In another example, resources and requirements for the Navy's multimiission *Zumwalt* class destroyer are principally managed by the Navy's Surface Warfare Division. Cost challenges within the program have required the Navy to reduce planned capabilities on the ship as well as procurement quantities, which has significantly reduced the *Zumwalt* class's ability and availability to provide naval surface fire support. This process of cost and capability trades has been managed by the Navy's Surface Warfare Division, not by the customer—represented by the Navy's Expeditionary Warfare Division—who depends on the delivered capabilities. As a result, current naval surface fire support capabilities of the *Zumwalt* class destroyer may not be aligned with the priorities of the expeditionary warfighter.

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<sup>10</sup> In contrast, the Expeditionary Warfare Division is charged with determining requirements and resources for amphibious and mine warfare ships, but the Navy instruction defines a formal role for the Surface Warfare Division in determinations for these ships as well.



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## Management of Command and Control Issues is Unresolved

The Joint Requirements Oversight Council has designated the Navy as the lead component to analyze the four gaps. The Navy, through its Surface Warfare Division, has already begun the analysis for the three engagement gaps presented in the initial capabilities document. However, no organization has been chosen to analyze the first gap in capability, which identified issues in fire support command and control. Any attempt to close this gap could have consequences for systems developed to engage targets, as they rely on the command and control architecture for target assignment and information.

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## Conclusions

Since the retirement of the battleships in 1992, the Navy and Marine Corps have worked to develop capabilities for naval surface fire support. The Navy and Marine Corps chose to pursue an approach in which the Extended Range Mmunition would provide near-term capabilities and the *Zumwalt* class destroyer would provide capabilities over the medium term. However, this investment strategy was defined by low levels of technical knowledge and poor estimates of the financial resources that would be needed to acquire this capability. As a result, the acquisition of systems for naval surface fire support has been plagued by technical and budgetary challenges that have delayed the fielding of any significant capability.

The recent joint analysis of fire support for forces operating in the littorals has been an important and constructive process in generating agreement and improving the knowledge base required to reconcile needs and assets. Yet, more work needs to be done to reconcile these differences, as evidenced by the gaps identified in the joint analysis. The presence of gaps in capabilities should be expected from any analysis of current resources, and it does not necessarily follow that all gaps must be closed with more resources. However, if gaps are to remain in place, this result should be the product of deliberate analysis and decision making that takes into account the views of the warfighter. At this point, there are several issues whose resolution will enable the kind of analysis needed to fully reconcile naval surface fire support needs with fire support assets.

First, although the Marine Corps has quantified many of its requirements for naval surface fire support in a way that allows the Navy to guide development of its systems, volume of fire remains ill-defined. While the Marine Corps maintains the importance of volume fires, the failure to even roughly quantify needs within thresholds and objectives leads to the absence of this capability in the systems the Navy develops as well as difficulty in planning munition procurement. By working with the Navy

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and other services to better define the effects required and to create operational concepts for a system or combination of systems that could achieve volume effects, the Marine Corps may be able to better provide this capability to warfighters in future conflicts.

Second, although the Navy and Marine Corps have reached an understanding on naval surface fire support requirements as a whole, translation of this understanding to the capabilities and quantities of individual systems must yet be reached. Over the past 10 years, the decisions made on individual systems such as the Extended Range Munition and the *Zumwalt* class destroyer have reduced the capabilities the Navy plans to make available to provide fire support for the Marine Corps's operations. These decisions were reached without providing a formal role for the Navy's Expeditionary Warfare Division in deciding the requirements and resources allocated to platforms that provide naval surface fire support, increasing risk that acquisition outcomes will not align with the priorities of the expeditionary warfighter.

Third, because of challenges posed by the development of the Extended Range Munition and the *Zumwalt* class destroyer, the Navy is now in a position in which it will rely more heavily on Extended Range Munition to provide fire support than originally planned. This program still faces significant development risks, a fact recognized by the decision of the Undersecretary of Defense for Acquisition, Technology & Logistics to elevate oversight of the program.

Finally, while the Navy's Surface Warfare Division has begun the analysis of gaps related to engaging targets, no office has been selected to analyze the gap in command and control of fire support in the littorals. To ensure that current and future systems provide a fire support function within the larger command and control network, it is important that this gap be analyzed in conjunction with the other identified capability gaps in joint fire support.

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## Recommendations for Executive Action

To improve the Department's efforts to address naval surface fire support needs, we are making the following four recommendations:

- To determine the desired effects for volume of fire, we recommend that the Secretary of Defense direct the Navy and Marine Corps to define quantitative requirements and operational concepts on use of volume fires, especially when using precision weapons for suppression or simultaneous strikes. This analysis should be used to 1) inform and

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update the non-nuclear ordnance requirements process used to determine procurement objectives for these munitions and 2) clarify the capability gap for volume fires as identified in the *Initial Capabilities Document for Joint Fires in Support of Expeditionary Operations in the Littorals*.

- In order to ensure that the systems providing naval surface fire support are aligned with the requirements and operating concepts of the forces they assist, we recommend that the Secretary of Defense direct the Navy to provide the Chief of Naval Operations's Expeditionary Warfare Division, as the division charged with establishing capabilities and requirements for naval surface fire support and liaison to the Marine Corps, a formal role in developing requirements, determining capabilities, and managing resources for Navy systems responsible for providing naval surface fire support.
- In light of the changes to the schedule, budget requirements, and design of the Extended Range Munition program, we recommend that the Secretary of Defense direct the Undersecretary of Defense for Acquisition, Technology & Logistics, as the program's milestone decision authority, conduct a comprehensive review of the program to validate progress and acquisition plans that will incorporate results from current and planned program studies and direct changes as necessary.
- Given the importance of command and control in coordinating fire support, especially in the complex environment imposed by joint operations in the littorals, we recommend that the Secretary of Defense direct the Navy to designate the appropriate organization for managing an analysis of alternatives related to this gap and ensure that the results of this analysis are coordinated with solutions for identified engagement gaps.

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## Agency Comments and Our Review

In written comments on a draft of this report, DOD concurred with the recommendation to define quantitative requirements and operational concepts on the use of volume fires as well as the recommendation to conduct a comprehensive review of the Extended Range Munition program.

DOD partially concurred with the recommendation to provide a formal role to the Expeditionary Warfare Division in decisions regarding naval surface fire support, stating that the department will review the existing role of the Director, Expeditionary Warfare and relevant Navy directives

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and make adjustments if necessary. It also stated that the role of Expeditionary Warfare was recently formalized for the munitions requirements and procurement process, but that the guns and launchers which fire these munitions are the responsibility of the Surface Warfare Division. In conducting its review, we believe the department should be mindful that naval surface fire support capability is not limited to munitions but also includes guns, ships, and other systems.

DOD also partially concurred with the recommendation to address the command and control gap identified by the *Initial Capabilities Document for Joint Fires in Support of Expeditionary Operations in the Littorals*, but indicated that full analysis of this gap will be deferred and not coordinated with the initial analysis of engagement gaps. This is surprising given that the initial capabilities document identified correcting weaknesses in command and control as the highest priority in its analysis. We are concerned that deferring command and control to a later analysis continues a history of inattention to this area.

DOD's written comments are included in their entirety in appendix II. The department also provided technical comments which were incorporated into the report as appropriate.

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We are sending copies of this report to the Honorable Donald H. Rumsfeld, Secretary of Defense; the Honorable Donald C. Winter, Secretary of the Navy; and interested congressional committees. We will also provide copies to others on request. We will also make copies available at no charge on the GAO Web site at <http://www.gao.gov>.

If you have any questions about this report or need additional information, please contact me at (202) 512-4841 or [francisp@gao.gov](mailto:francisp@gao.gov). Contact points for our Office of Congressional Relations and Public Affairs may be found on the last page of this report. GAO Staff who made contributions to this report are listed in appendix III.



Paul L. Francis  
Director  
Acquisition and Sourcing Management

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# Appendix I: Scope and Methodology

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To assess whether well-defined requirements for naval surface fire support have been established, we reviewed current and historical Navy, Marine Corps, and joint force documents that identify requirements related to naval surface fire support and that explain operational concepts for expeditionary warfare. We analyzed and compared these documents to determine 1) when the joint services reached formal agreement on naval surface fire support requirements, 2) how these requirements align with the Marine Corps's key operating concepts for expeditionary warfare, and 3) the degree to which these requirements include clear, quantitative measures of performance. To supplement this analysis, we further discussed these issues with Navy, Marine Corps, and joint force officials responsible for establishing naval surface fire support requirements. We also interviewed Navy program officials responsible for developing and procuring the Extended Range Munition and *Zumwalt* class destroyer to understand how naval surface fire support requirements have been incorporated into these programs.

To assess the Navy's progress in developing and fielding the Extended Range Munition, the *Zumwalt* class destroyer, and future systems for naval surface fire support, we analyzed key program documentation including performance requirements, cost estimates, budget submissions, acquisition strategies, development and demonstration contracts, and testing plans and results. We also drew from our prior work related to best practices and development and cost challenges in the Extended Range Munition and *Zumwalt* class destroyer programs. In addition, we reviewed Department of Defense reports related to these and other programs for naval surface fire support. To supplement our analysis, we interviewed Navy and Office of the Secretary of Defense officials responsible for managing resources and requirements in naval surface fire support programs. We also discussed program challenges and risks with the acquisition managers, contractors, and testing community associated with each system.

To determine whether current Navy systems in development will fulfill naval surface fire support requirements, we comparatively analyzed the joint services' most recent requirements document related to naval surface fire support—the *Initial Capabilities Document for Joint Fires in Support of Expeditionary Operations in the Littorals*—with the validated performance requirements for the Extended Range Munition and *Zumwalt* class destroyer. To identify actions taken to address situations where naval surface fire support requirements may not fully align with the capabilities planned for these systems, we interviewed officials from the Navy, Marine Corps, joint services, and Office of the Secretary of Defense.

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To address our objectives, we visited and interviewed officials from the Navy's Surface Warfare and Expeditionary Warfare Divisions; the Marine Corps's Combat Development Command and Plans, Policies, and Operations offices; the Program Executive Office for Integrated Warfare Systems; and the Extended Range Mmunition and Zumwalt class destroyer program offices. We also met with officials from the Department of Defense's Office of the Inspector General, the Office of the Secretary of Defense, Joint Staff, Joint Forces Command, the Naval Surface Warfare Center—Dahlgren Division, the Office of Naval Research, Affordable Weapon System project office, the Defense Contract Management Agency, Raytheon Missile Systems, BAE Systems, and Alliant Techsystems.

We conducted our analysis from February 2006 to November 2006 in accordance with generally accepted government auditing standards.

# Appendix II: Comments from the Department of Defense

Note: Page numbers in the draft report may differ from those in this report.



ACQUISITION,  
TECHNOLOGY  
AND LOGISTICS

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NOV 15 2006

Mr. Paul L. Francis  
Director, Acquisition and Sourcing Management  
U.S. Government Accountability Office  
441 G Street, N.W.  
Washington, D.C. 20548

Dear Mr. Francis:

This is the Department of Defense (DoD) response to the GAO Draft Report, "DEFENSE ACQUISITIONS: Challenges Remain in Developing Requirements and Capabilities for Naval Surface Fire Support" (GAO Code 120520/GAO-07-115). The Department's comments on the recommendations are attached.

The Department partially concurs with recommendations 2 and 4, which relate to clarifying the role of the Chief of Naval Operations' Expeditionary Warfare Directorate in naval surface fire support matters, and designating an appropriate organization for managing an analysis of alternatives to close command and control gaps identified in joint expeditionary fires.

The Department concurs with recommendations 1 and 3, which relate to defining quantitative requirements and operational concepts on the use of volume fires, and to conducting a comprehensive review of the Extended Range Munition program.

The Department appreciates the opportunity to comment on the draft report. Technical comments were provided separately. For further questions concerning this report, please contact Darlene Costello, Deputy Director, Naval Warfare, 703-697-2205.

Sincerely,

David G. Ahern  
Director  
Portfolio Systems Acquisition



GAO DRAFT REPORT DATED OCTOBER 16, 2006  
GAO-07-115 (GAO CODE 120520)

"DEFENSE ACQUISITIONS: CHALLENGES REMAIN IN DEVELOPING  
REQUIREMENTS AND CAPABILITIES FOR NAVAL SURFACE FIRE SUPPORT"

DEPARTMENT OF DEFENSE COMMENTS  
TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense direct the Navy and Marine Corps to define quantitative requirements and operational concepts on use of volume fires, especially when using precision weapons for suppression or simultaneous strikes to determine the desired effects for volume of fire. (p. 28/GAO Draft Report)

DOD RESPONSE: The DoD concurs with the recommendation. Long range precision guided Naval Surface Fire Support (NSFS) munitions have been developed specifically to support Marine Corps operational requirements. These operational requirements directly affect the size and cost of NSFS munitions. The DoD has yet to find an acceptable absolute metric to determine how many of these new precise projectiles might be needed at all ranges to create volume effects similar to the traditional practice of using large quantities of unguided munitions at relatively short ranges. The DoD recognizes that a trade-off of increased range and precision for decreased capability to provide volume fires might exist and might have some inherent risk. But, the amount of risk is highly dependent on the scenario.

The solution to mitigating the gap in volume of fires is more appropriately addressed by developing tactics, techniques, procedures, and doctrine for using all elements of the fires triad (air, ground, and sea) to achieve volume effects at the ranges required by new operational concepts. In the interim, the DoD will continue to refine methods for estimating required quantities of precision ammunition intended for fire support applications, including volume fires, and the Navy will incorporate those improvements into the Non-Nuclear Ordnance Requirements model as needed.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense direct the Navy to provide the Chief of Naval Operations' Expeditionary Warfare Directorate, as the directorate charged with establishing capabilities and requirements for naval surface fire support and liaison to the Marine Corps, a formal role in developing requirements, determining capabilities and managing resources for Navy systems responsible for providing naval surface fire support to ensure that the systems providing naval surface fire



support are aligned with the requirements and operating concepts of the forces they assist. (p. 28/GAO Draft Report)

DOD RESPONSE: The DoD partially concurs with the recommendation. The position of Director, Expeditionary Warfare was established by Congress in section 5038 of Title 10, United States Code, which states in part that, "The principle duty of the Director, Expeditionary Warfare shall be to supervise the performance of all staff responsibilities of the Chief of Naval Operations regarding expeditionary warfare, including responsibilities regarding amphibious lift, mine warfare, naval fire support, and other missions essential to supporting expeditionary warfare."

Within the Department of the Navy, traditional staff relationships exist between the Director, Surface Warfare, the Director Expeditionary Warfare, the Marine Corps Combat Development Command, and Headquarters Marine Corps. As recently as 2006, the Navy clarified the role of the Director, Expeditionary Warfare (N85) in a Chief of Naval Operations Notice. The Navy directive formalizes the Director, Expeditionary Warfare role in the DoD Munitions Requirements Process as well as its role in validating procurement quantities for NSFS munitions. The guns and launchers that provide NSFS for the warfighters and critical force protection for the fleet, and facilitate the Sea Shield pillar of the Navy 21 Strategy, are the responsibilities of the Director, Surface Warfare (N86). The Expeditionary Warfare Directorate can fulfill its Title 10 responsibilities with its current authorities in coordination with other Navy staff directorates through the Navy's Resources and Requirements Review Board.

The Department agrees to review the existing Navy directives and the role of the Director, Expeditionary Warfare in NSFS and to direct the Navy to make any necessary adjustments.

RECOMMENDATION 3: The GAO recommended that the Secretary of Defense direct the Under Secretary of Defense for Acquisition, Technology & Logistics, as the program's milestone decision authority, to conduct a comprehensive review of the program to validate progress and acquisition plans and direct changes as necessary in light of the changes to the schedule, budget requirements, and design of the Extended Range Munition Program. (p. 28/GAO Draft Report)

DOD RESPONSE: The DoD concurs with the recommendation. The Extended Range Munition program is a Major Defense Acquisition Program (ACAT ID). A comprehensive review of the program is being conducted by USD(AT&L). The review includes updating the acquisition strategy, the acquisition program baseline, the systems engineering plan, and the test & evaluation master plan. These key acquisition documents will align to the new program plan to provide an initial operational capability in 2011. The USD(AT&L) will approve the updated acquisition strategy, the new acquisition program baseline, and

will approve the updated acquisition strategy, the new acquisition program baseline, and the updated systems engineering plan. The Director, Operational Test and Evaluation, and the Director, Systems and Software Engineering will approve the updated test & evaluation master plan. A Milestone C review by the Defense Acquisition Board is planned for fiscal year 2009 to determine the readiness of the program to enter into low rate initial production.

The Navy established annual progress gates for the program, for which OSD will review compliance before continuing the program. The first progress gate is completion of a reliability test series planned in late FY2008. This gate will ensure that the munition can be produced and fired successfully in production representative quantities of more than one or two test rounds. If the reliability measure is met, the program will proceed to land based qualification tests to demonstrate that the munition can meet all key performance parameters. When that gate is successfully passed, the program will proceed to the Milestone C review. The final progress gate is successful completion of sea-based developmental and operational testing. Upon successful completion of that progress gate, the program will seek approval from the Milestone Decision Authority to begin full rate production.

RECOMMENDATION 4: The GAO recommended that the Secretary of Defense direct the Navy to designate the appropriate organization for managing an analysis of alternatives related to this gap and ensure that the results of this analysis are coordinated with solutions for identified engagement gaps, given the importance of command and control in coordinating fire support, especially in the complex environment imposed by joint operations in the littorals. (p. 28/GAO Draft Report)

DOD RESPONSE: The DoD partially concurs with the recommendation. The Navy is currently conducting internal analyses on closing some of the gaps identified in the Joint Fires in Support of Expeditionary Operations in the Littorals Initial Capabilities Document (ICD). A formal Analysis of Alternatives (AoA) will commence when USD(AT&L) issues the required guidance, which is anticipated in the near future. The command and control gap (gap 1 in the ICD) is the only gap that is not in the engagement portion of the fires kill chain. Phase 1 of the AoA will address the engagement portion of the kill chain using near term weapon systems in conjunction with existing and program of record command and control capabilities. When the DoD is prepared to undertake Phase 2 of the AoA, which will begin to address means to close the command and control gap and will expand the engagement analyses to weapon systems available in the mid-term, an appropriate organization within DoD will be assigned to manage the AoA efforts in the command and control area. That lead organization might not reside within the Department of the Navy.

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# Appendix III: GAO Contacts and Staff Acknowledgments

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## GAO Contact

Paul L. Francis (202) 512-4841

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## Staff Acknowledgments

Key contributors to this report were Karen Zuckerstein, Assistant Director; J. Kristopher Keener; Christopher R. Durbin; Ryan Consaul; and Lily Chin.

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